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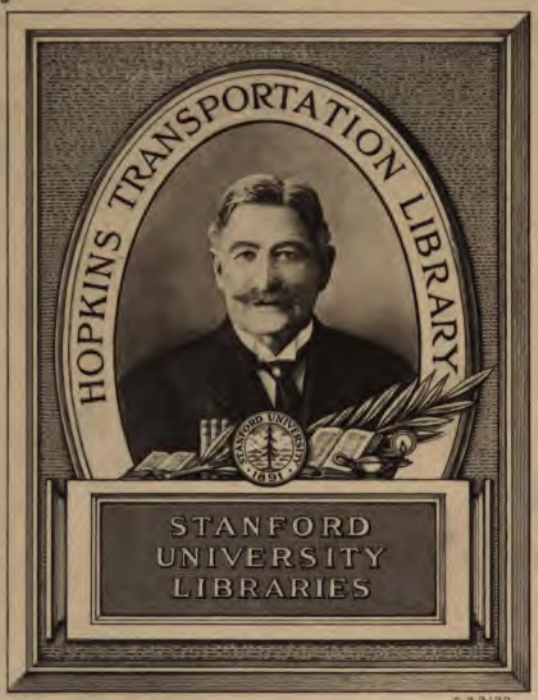
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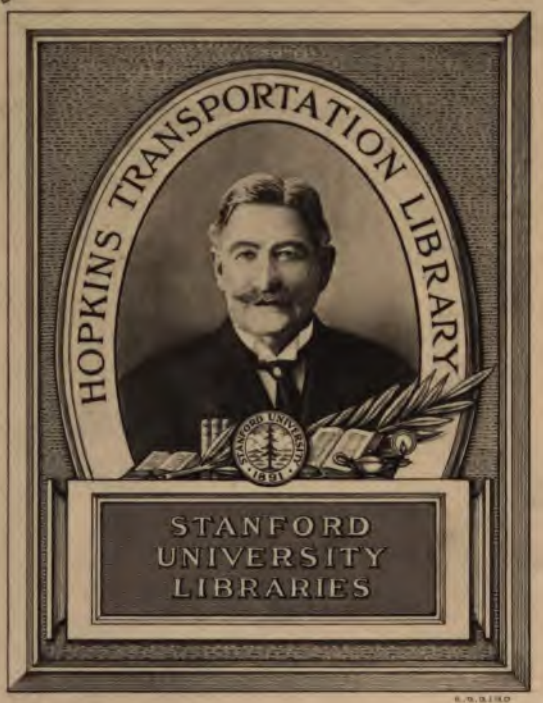
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The PANAMA CANAL

Illustrated by Color Photography from the Original Autochrome Photographs

by

EARLE HARRISON

New York
Moffat, Yard and Company
1913

DEDICATED TO

THE

GREAT ARMY OF WORKERS

ON

THE ISTHMUS

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THE GREAT GATES TO THE LOCK CHAMBERS.

The huge gates to the lock chambers are immense steel structures, 7 feet thick and 85 feet high, and each leaf 65 feet wide. They are, in reality, a pair of gates, for they open from the center, swinging backward and inward into recesses provided in the side of the lock walls. While appearing solid, they are constructed like a great "honey-comb," the sides covered with heavy steel plates overlapping each other and riveted together. This riveting required 5,750,000 rivets. There are, all told, in the Canal locks 46 gates or 92 "leaves," each weighing about 700 tons. To erect these frame works of steel, and then cover them with the plates, required months of time and hundreds of men. Holes had to be drilled through two thicknesses of steel plate—as they overlap each other—before the rivets heated to white heat were driven home and headed by pneumatic riveting machines.

It is hard to imagine that such immense structures, weighing hundreds of tons, are swung on hinges, opening and closing as easily as a parlor door. The gates are of *miter* design and their edges are hand-ground, so that when closed they are water tight. To open or close the gates, requires but two minutes time, the movement being governed by specially constructed machinery, which is operated by electric motors controlled by levers placed in a tower upon the center wall of the locks. A man located in this tower has control of the gates and also the letting in and removing of the water from the lock chamber, which raises or lowers the vessel.

WHERE THE CANAL CROSSES THE CORDILLERAS.

Nothing could be truer than the statement that "the canal workers have removed mountains." Culebra Cut might well be termed "The Grand Canyon of the Canal," for so stupendous will it appear when completed that the most vivid imagination can scarcely imagine it the work of man. For nearly a century it has been the dream of nations, that some day man would succeed in tearing asunder the mountains forming the Continental Divide, allowing the waters of the Atlantic to unite with the placid Pacific through a great channel created by man, for the welfare of his posterity. Where the canal crosses the Cordilleras a great ravine had to be excavated in order to allow the water from Gatun Lake to flow through to the locks at Pedro Miguel. The cut at this point is about 500 feet deep and a half mile wide at the top. The excavation here has literally been done step by step, for while one lot of steam shovels were digging, and loading upon cars the rock and earth from one elevation, others were at work at lower elevations.

A group of drills are shown in the center of the picture, drilling holes which are loaded with dynamite and exploded to loosen the material for the steam shovels. To the left of the drills, is a dirt train loaded with rock and earth, ready to start for the dumping ground six miles away. In the lower right hand corner is shown one of the huge steam shovels, which digs and loads five cubic yards of earth or rock each time the dipper is swung.

CULEBRA CUT, LOOKING FROM CONTRACTOR'S HILL TOWARDS THE ATLANTIC.

It is hard to realize the immensity of Culebra Cut, but when you walk its entire length—a god half day's journey—and gaze up at the top of the cut, where the palm and cocoanut trees appear as small bushes from such a great distance below them, you begin to understand why the Canal remained uncompleted for years. In addition to the enormous length and depth of Culebra Cut, it is sufficiently wide and will contain enough water when completed, to allow two boats as large as the mammoth Imperator to pass anywhere through the nine miles of the Cut.

Looking from Contractor's Hill a wonderful view of Culebra Cut is obtained. To the right is a slide, started in January 1913, which has given the army of canal workers a great deal of trouble. These slides start slowly and are several months in movement before they finally pour into the cut, covering up miles of the tracks used by the dirt trains for hauling out the material from the cut. On several occasions the mammoth steam shovels have been entirely buried by these slides.

This picture shows clearly the step by step or *"bench"* method of excavation used through Culebra Cut. The queer cast of color prevailing throughout the cut is young vegetation, which springs up almost over night in the tropics. The fact that vegetation is so prolific in the tropics, and of such rapid growth, will greatly assist in holding back small slides, which otherwise might prove of serious consequence.

THE CULEBRA CUT, LOOKING FROM CONTRACTOR'S HILL TOWARDS THE PACIFIC.

The excavating of Culebra Cut was the greatest undertaking in the building of the Panama Canal.

In 1905 the United States Government began work in Culebra Cut on a scale so tremendous that it attracted the attention of the entire world.

For three years following the invasion of the Isthmus by the Americans, the task of digging a great canal through the huge mountains and impenetrable jungles, was enough to discourage any corps of engineers and laborers. To add to the seeming impossibility of the undertaking, there was a constant battle against yellow fever during these first three years. The Government began a "clean-up campaign" and a war on mosquitoes soon after the canal work began, and the Americans worked fearlessly through all this period of suffering and death. Each day thousands of cubic yards of earth and rock were removed from the Cut.

Since 1905 the army of canal workers, guided by the ingenuity of our American engineers, and equipped with the most powerful modern machinery, has blown apart, shoveled up and carried away more than 90,000,000 cubic yards of rock and earth from Culebra Cut. To-day the work is more than 92 per cent. completed.

Through the period of yellow fever epidemics, and constant tropical diseases, and the intense scorching sun, the men on the job have labored steadily on day after day, to accomplish this wonderful work, until now it is practically completed. So immense is the Culebra Cut that every ship crossing the Atlantic Ocean could easily be buried in it.

THE DIRT TRAINS BEING LOADED IN CULEBRA CUT.

The great work of excavating has literally been done step by step, for while the steam shovels are working at one level, others are digging and loading from another elevation. Trains of from 20 to 30 cars, drawn by powerful locomotives, remove the dirt and rock dug and loaded by these shovels.

Whether these important trains are moving over the many miles of tracks built especially to enable them to reach the various dumping grounds, or running over the main line of the Panama Railroad, it is all the same. Nothing can stop them, not even Colonel Goethal's private car. They have absolute right of way. All through the hot day, until the tropical sun has sunk behind the horizon of silhouetted palm and cocoanut trees, the dirt trains are constantly rushing along from the great excavation to the dumping grounds. They are not even still when being loaded; for as the great steam shovels pile on the dirt the train slowly moves along, in order that the next dipper filled with earth can be dumped upon an empty part of the car, and when the last car is loaded, off to the dump it goes, at a speed that would do credit to an American passenger train.

Upon reaching its destination, no time is lost in unloading. A great, plow-like affair scrapes the dirt off the entire train of twenty cars in less than ten minutes and back for another load it goes.

There are two types of trains used on the canal. One is made up of steel cars automatically dumped by compressed air from the engine, while the other style is composed of ordinary flat cars. Unloading of the latter type cars is done by this plow-like arrangement, drawn along the length of the train by a cable.

TYPE OF GIANT STEAM SHOVEL USED IN THE CONSTRUCTION OF THE PANAMA CANAL.

When our country began work on the Isthmus in 1904 nearly all the French equipment had to be discarded. It was entirely inadequate to accomplish the task undertaken. What the French, guided by De Lesseps, had hoped to accomplish with hand shovels and tiny dirt cars, together with a few mechanical dirt-digging machines of an impracticable character, the United States planned to do by modern machinery.

Each one of the gigantic American shovels can do more work in one day than one thousand French laborers accomplished in the same time. Each is operated by two men, sheltered from the intense tropical sun by a cabin on the shovel. The shovels with their great steel hands, almost human in their movements, reach down, pick up five cubic yards of earth and rock, and load it on the dirt trains.

The men operating these shovels form a fond attachment for them. And it seems as if the shovels felt this regard, so quickly and accurately do they respond to the guiding hand of the man at the lever. It is the ambition of each shovelman to take out the greatest number of cubic yards of material from the cut during the day. So great is the rivalry among the shovels that the world's record for steam shovel excavation has been made by the canal shovels in spite of the pernicious effect of the tropical climate. It is hardly conceivable, but nevertheless true, that this spirit of rivalry and pride felt by the men for their shovels has increased the efficiency to such an extent that one shovel has a record of digging and loading 5,554 cubic yards of earth and rock in one day. This, if loaded on wagons, would have required 3,600 two-horse teams to carry off.

THE GREAT SEA-LEVEL DITCH FROM MIRAFLORES LOCK TO BALBOA, THE PACIFIC ENTRANCE.

Centuries ago when Balboa, crossing the Isthmus of Panama, stood upon the crest of the mountain forming the great Continental Divide, and viewed for the first time the distant waters of the Pacific, he never imagined that some day man would bring the waters of this great ocean across the intervening miles to the foot of the mountain upon which he stood.

Yet this is what will soon be accomplished by the Americans, for, with the exception of a short distance, the big ditch is complete, and the waters of the Pacific now flow to and fro as the tide comes in or goes out, to within a distance of one and one-half miles of Miraflores.

Standing on the center wall of the Miraflores locks, an excellent view is obtained of the work of digging the great sea-level ditch from these locks to the dike a mile or more away, and, when this dike is removed, the waters from the Pacific will flow into the locks.

A vessel in approaching the canal from the Pacific entrance enters the canal at Balboa, where it travels through a sea-level channel a distance of about four miles to the Miraflores locks. Here the vessel is lifted twice, the combined height being 54 feet, traveling a distance of a mile and a half at this elevation, when it enters the lock of Pedro Miguel, where it is lifted once again 30½ feet. Upon this level, the vessel crosses the Isthmus to Gatun locks, where it is lowered by three flights of locks, 85 feet to the sea level of the Atlantic Ocean.

GATUN LOCKS, LOOKING FROM THE TOP OF THE CENTER WALL TOWARDS THE ATLANTIC ENTRANCE TO THE CANAL.

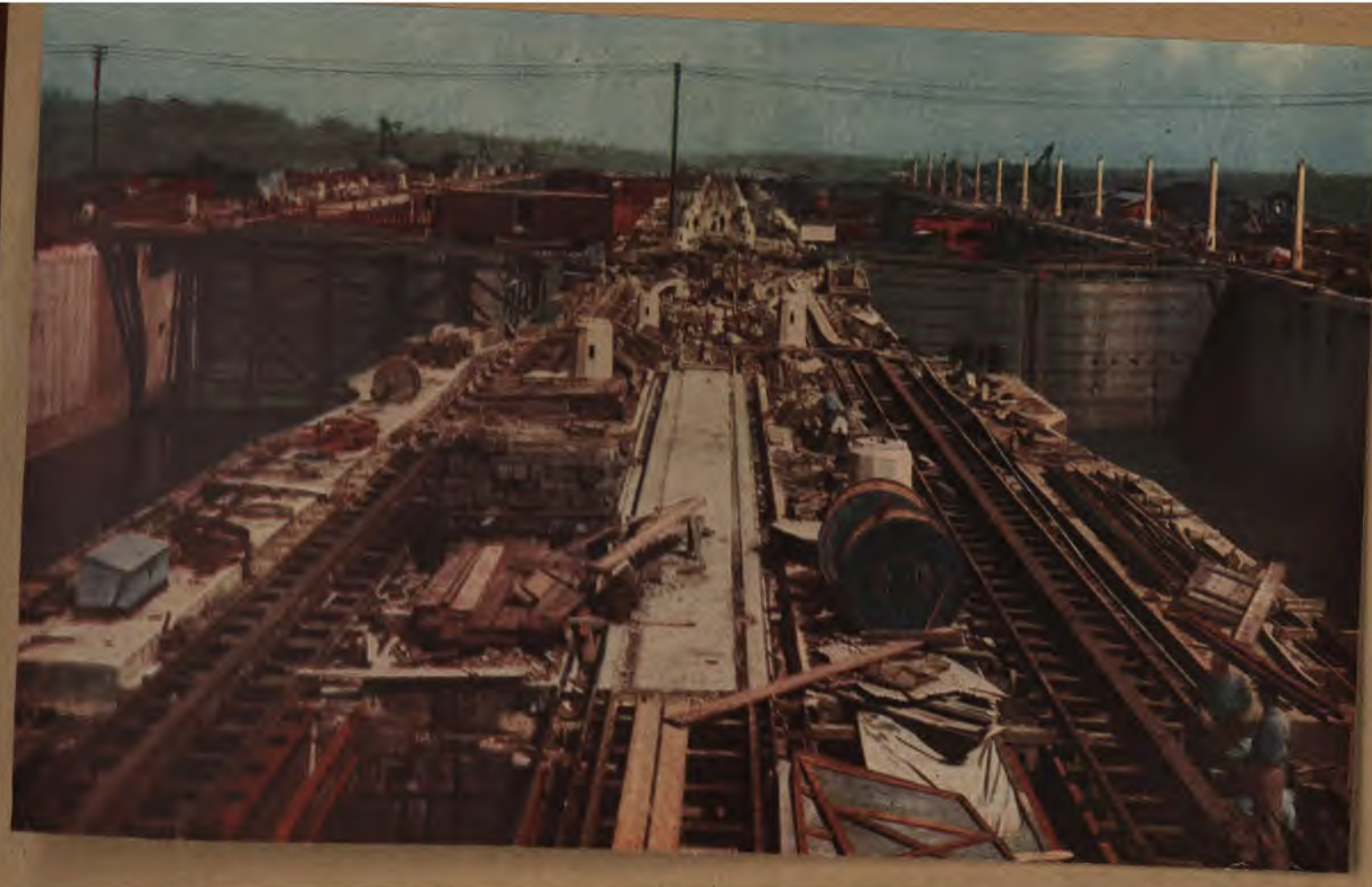
The upper gates of the Gatun locks are closed in the picture, holding back the water of the lake. A ship in its progress through these locks is lifted three times, the combined height being 85 feet. The Gatun locks, as well as those at Miraflores and the single lock at Pedro Miguel, are in pairs, parallel in arrangement. The arrangement of valves and operating mechanism is such that one side will be used for Pacific-going vessels, the opposite for Atlantic-bound boats. Each lock chamber is 1,000 feet long and 110 feet wide, and is constructed of concrete.

The tracks shown in the picture, running along the center wall, are for the electric towing locomotives which will haul the ship into the lock and hold it while being lifted.

Four of these locomotives will be required to handle a ship; two will tow from the bow, while the other two will guide by lines fastened to the stern of the vessel.

Every precaution and safeguard has been used to prevent the possibility of a vessel ramming the gates. A chain is stretched across the locks far enough from the gates, so that in the event a vessel did force her way into the locks, she would come in contact with this chain; which is automatically played out until the vessel is stopped, thus avoiding injury to the boat or the lock.

The locks will be brilliantly illuminated by electric lights arranged in clusters on the concrete posts shown along the wall of the lock. The power to run the electric locomotive, as well as operate the gates and illuminate the locks, will be generated by the hydro-electric plant—operated by the overflow from Gatun Lake at the Spillway.



A LOCK CHAMBER ON THE PANAMA CANAL AT PEDRO MIGUEL.

Imagine if you can a great tub, one thousand feet long, more than one hundred feet broad, and eighty-five feet deep. Imagine that this huge tub has at its ends immense gates as high as a seven-story building and half a city block wide. Then you can form some idea of one of the most impressive features of the Panama Canal—the locks. The parts of the locks that most strongly kindle the imagination are the great steel gates. There are ninety-two of these gates, or forty-six pairs, half of them at Gatun, the other half at Pedro Miguel and Miraflores. The construction and operation of them all are identically the same.* These gates were made in the United States and were shipped to the canal in sections and parts of sections. The greater task of erection was left to the workmen sent by the contractors to the Isthmus for this purpose.

The average time required to fill or empty a lock, thus raising or lowering the boat, as the case may be, is fifteen minutes.

The time required to pass a vessel through all the locks, is estimated at three hours, one hour and a half at Gatun, and about the same length of time in the three locks on the Pacific side, the one at Pedro Miguel and the two at Miraflores.

The time of passage of a vessel through the entire Canal, is estimated at from 10 to 12 hours, according to the size of the ship and the rate of speed she can travel.

* There is some variation in the height of the gates. The highest gate is located at Miraflores lock, where a variation in the Pacific tide of 20 feet has to be taken care of.

THE GREAT GATES TO PEDRO MIGUEL LOCKS, NOW VIRTUALLY COMPLETED.

Like the other gates at Gatun and Miraflores, those of the Pedro Miguel locks are each 65 feet wide and 7 feet thick. A comprehensive idea of the construction is gained here, for only one side of the gate has the steel plates in place, the "honey-comb" construction of the gate being plainly visible.

Some idea of the immensity of the gates can be gained by comparing their heights to that of the man standing upon the top of the gate in foreground. This gate is only two-thirds as high as the gates shown in the picture just beyond. A dozen men could easily be placed in one of the "honeycomb" openings in the gate.

A ship is lifted but once in passing through Pedro Miguel lock, but despite the fact that it is the smallest of the locks, the others being double and triple lifts, it is most impressive, for its shortness in length emphasizes its extreme width and depth.

THE GREAT CONCRETE WALLS OF THE LOCKS.

It is impossible to conceive the immensity of the great concrete walls of the locks, for the entire canal is constructed upon such a huge scale. Inside of these walls are huge passages as large as the Pennsylvania tube under the Hudson River.

The side walls, as well as the centre wall of all the locks, are the same. The side walls are from 45 to 50 feet wide at the bottom, and narrow from a point 24 1-3 feet above the floor of the lock to a width of 8 feet at the top.

The centre wall is 60 feet thick at the bottom, and rises to a height of about 81 feet, and is the same thickness along its entire height.

At a point of 42 1-3 feet above the surface of the lock bottom, and 15 feet above, the culvert, which runs through the centre wall, will be a U-shaped space, which will be 19 feet wide at the bottom and 44 feet wide at the top.

This tunnel or U-shaped space will be divided into three stories or galleries. The lowest will be for drainage, the next above will be used for the wires which carry the current to operate the water valve and machinery for opening and closing the gates. The top tunnel will be a passage for the man operating the locks.

THE SPILLWAY.

The Spillway is a great crescent-shaped concrete dam 1,200 feet long. It holds back the water of the Gatun Lake during the dry season and regulates the overflow during the rainy season. The crest of the dam is 16 feet below the normal level of the lake. On top of the dam are 13 concrete piers, between which are mounted fourteen 44-ton regulating gates electrically operated. By raising or closing them the overflow from the lake is controlled. When fully raised a discharge of 140,000 cu. ft. per second can be handled. In this picture the water is shown coming out of the sluiceways at the bottom of the dam.

The smallest run-off of water over the basin, which is now Gatun Lake, during the past twenty years, was 146 billion (146,000,000,000) cubic feet, which is sufficient to operate the locks through the entire year, for it is only during the three dry months that the lake will have to be called upon, for during the rest of the year the constant tropical showers supply more water than is necessary, and it is discharged through the spillway. During the three months of dry season, there will be sufficient water in the lake, allowing for evaporation, leakage, etc., to make on the average of 41 lockages per day, which is considered more than is practical to make during the 24 hours.

It is here at the spillway that the government has built the great hydro-electric plant, which generates the power for all the lock machinery and furnishes the light for the entire canal, including the many lighthouses which guide the vessel in its course through the canal.

THE ATLANTIC ENTRANCE TO THE CANAL.

From the Atlantic entrance to the Gatun Locks the canal appears as a natural waterway. The work here is practically completed. An old French dredge, working wonderfully well, is clearing the channel near the entrance to the Gatun locks.

The first five miles in the journey from the Atlantic coast through the canal is along this sea-level channel. While it is only five miles from the coast line of the Atlantic Ocean to the Gatun locks, it is in reality ten miles of canal channel, for an immense amount of dredging was necessary to secure a channel of sufficient depth from the shore to deep water. In addition to this, a great stone breakwater had to be built from Toro Point, near the town of Cristobal, out to sea for a distance of two miles. This breakwater is fifteen feet wide at the top, and extends above the water at high tide a distance of ten feet. It required about 2,540,000 cubic yards of rock to construct this breakwater. At the Gatun Locks, the vessel is lifted 85 feet, when it enters Gatun Lake. Passing through Gatun Lake, the vessel enters Bas Obispo Cut, after which come Culebra Cut, and then the Pedro Miguel Lock. Passing through Pedro Miguel, the vessel travels one and a half miles to Miraflores, where it is lowered to sea level and passes through a sea-level channel four miles in length to the Pacific Ocean.

THE CHAGRES RIVER IN THE DRY SEASON.

The Chagres River, the main source of water supply for Gatun Lake, is most unimpressive in size during the dry season, seemingly a very small stream, but during the rainy season it is a huge flood of water. It has often been known to rise 30 feet in twenty-four hours. As the Isthmus is not able to boast of a single decent or even usable road outside of the Canal Zone, the natives make use of the river for a thoroughfare. There is no more beautiful river to be found anywhere than the Chagres.

With both banks heavily timbered with various tropical trees which are reflected in the crystal-like clearness of the waters, it often appears with charms peculiarly its own.

Almost daily can be seen the long, narrow "dugouts" of the natives loaded with bananas, silently going along the river on their way to the markets at Empire and Culebra.

The Chagres River flows into the canal near the Atlantic end of Culebra Cut, or more clearly spoken, about halfway between the Gatun Locks and Miraflores.

GATUN LAKE.

Gatun Lake will empound the waters of a basin comprising 1,320 square miles. When the surface of the lake is 85 feet above sea level, it will have an area of 164 square miles, and will contain about 206,000,000,000 cubic feet of water. During the rainy season, which covers a period of eight or nine months out of the year, the lake will be kept full by the constant tropical showers, and a surplus will be stored for the dry season. As navigation through the lake can be carried on with about 41 feet of water, there will be stored for the dry season an ample amount to operate the Canal.

A ship in traveling through the canal, proceeds under her own power through the lake, Culebra Cut, and both the Atlantic and Pacific approaches to the locks. The only towing is while the ship is being put through the locks.

Through the first 16 miles from Gatun, the channel in the lake is 1,000 feet. Then for four miles the channel is 800 feet, and the remaining four miles have a channel of 500 feet.

The depth of the lake will vary from 45 to 85 feet. The water line in Culebra Cut will be the same as the minimum lake depth, 45 feet.

Three hundred feet is the minimum channel width of the canal.

"THE OLD SEA WALL" WITH NEW PANAMA IN THE DISTANCE.

The Old Sea Wall at Panama still remains just as it was in the days of romance, when the Spanish Buccaneers stood upon it, gazing seaward towards the treasures of Peru and Ecuador.

Beneath the old wall is the Prison where the Spanish years ago held captive their slaves, and to-day the Panámanian Government uses the Prison for confining those who break the country's laws.

One of the peculiarities of the Isthmus is the difference of tides between the Atlantic and Pacific Oceans.

At low tide the Pacific recedes several hundred feet away from the old sea wall, while at high tide it washes high up upon it, the difference between high and low tide being 21 feet in the Pacific, whereas it is only 1 4-10 in the Atlantic.

The old city was destroyed by Morgan in 1671. The new city was founded in 1673. With the clear blue water of the Pacific washing against it, and the coloring in the Spanish architecture beyond, the Old Sea Wall with its environment remains a relic of the days of romance.

Rising above the red tiled roofs of the town are seen the twin towers of the Cathedral, embellished with a myriad flashing pearl shells dredged from the famous pearl fisheries of Panama Bay.

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